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(54) **SYSTEM AND METHOD FOR VARIABLE RATE IRRIGATION WIND CONTROL AND COMPENSATION**

SYSTEM UND VERFAHREN ZUR STEUERUNG UND KOMPENSATION EINES BEWÄSSERUNGSWINDES MIT VARIABLER RATE

SYSTÈME ET PROCÉDÉ DE RÉGULATION ET DE COMPENSATION DU VENT D'UN SYSTÈME D'IRRIGATION À DÉBIT VARIABLE

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EP 3 661 352 B1

Description

BACKGROUND AND FIELD OF THE PRESENT INVENTION: [005] Field of the Present invention

[0001] The present invention relates generally to a system for irrigation management and, more particularly, to a system which combines field mapping and control software to effectively manage individual sprinkler control on a mechanical irrigation machine.

Background of the Invention

[0002] Modern center pivot and linear irrigation systems generally include interconnected spans (e.g., irrigation spans) supported by one or more tower structures to support the conduits (e.g., water pipe sections). In turn, the conduits are further attached to sprinkler/nozzle systems which spray water (or other applicants) in a desired pattern. With present technology, sprinkler controls are determined and varied based on fixed field design patterns. For each fixed design pattern, the selected nozzles are controlled to irrigate a defined area pattern and they cannot be otherwise controlled or adjusted. This limitation of the prior art creates significant issues in tailoring irrigation patterns to a variety of circumstances. For this reason, large amounts of water and chemicals are wasted each year. For example, during high wind conditions water can drift from the desired application area to other areas. This also results in incorrect application rates for a targeted field which defeats the purpose of individual sprinkler control. Additionally, changes in the elevation of a selected field can also cause water to drift outside of a desired application area.

[0003] At present, the prior art provides control modules which are limited to adjusting watering schedules based on rain meters and the like. For example, U.S. Published Application No. US20120221154 to Runge discloses an irrigation control module that can adjust a watering schedule for a connected irrigation controller based on weather data provided by a local weather station. Similarly, U.S. Published Application No. US20100032493 to Abts discloses a method for automatically adjusting the water application rate of an irrigation system which is movable over an agricultural field based on data from environmental sensors and crop or plant sensors. Further, U.S. Patent No. 6,947,811 to Addink discloses systems and methods in which an irrigation controller is programmed to adjust an irrigation schedule according to a condition of a plant being irrigated.

WO2013/006213 A1 of Lindsay Corporation discloses a control system for controlling of an irrigation end gun to accommodate weather conditions such as wind direction and speed.

[0004] While helpful, the prior art fails to teach or suggest any system which enables a user to manage and adjust irrigation controls using field mapping, topography and detected weather conditions. Further, the prior art fails to teach or suggest the use of field mapping and control software to effectively manage individual sprinklers based on current wind conditions. At present, the chosen method for adjusting to high wind conditions is often simply shutting down watering operations.

[0005] In order to overcome the limitations of the prior art, a system is needed which is able to combine field mapping and control software to effectively manage individual sprinkler functions in a variety of different conditions.

Summary of the Present Invention

[0006] To address the shortcomings presented in the prior art, the present invention provides a system as set out in the appended claims. The invention combines field mapping and control software to monitor machine location and angles in coordination with a field specific program. In embodiments of the invention, a controller controls a variable rate irrigation system including control of individual sprinklers. The controller may monitor wind speeds and make adjustments to the water system based on the monitored wind speeds. Preferably, these adjustments may include determining the operation rate of a variable rate pump as well as turning selected sprinklers on or off in adjusted locations or entirely.

The controller makes adjustments to a predesigned irrigation course (including the speed or path of an irrigation machine) based on detected weather and topographical conditions.

[0007] The controller is further operable to adjust the irrigation pattern, valves, sprinklers, and other aspects of the system to create a corrected distribution pattern which will result in reduced product loss. It may create a corrected distribution pattern by use of additional factors such as: distribution droplet size, height of nozzle from the ground, nozzle direction, direction and speed of the irrigation machine, and the slope of a given field and other detected conditions. The controller may selectively adjust individual sprinklers or sets of sprinklers so that groups of sprinklers may be turned on or off or run at reduced water pressures depending on detected conditions.

[0008] The system may preferably monitor a mapped set of boundaries and receive data regarding a variety of weather factors including wind monitoring (speed, direction, averages, and gusts) and preferably may make adjustments to the system (i.e. water pressure, sprinkler parameters and/or system travel speed) to adjust and modify the shape of a desired distribution area. The controller is integrated into the control system of an irrigation machine so that it may control any or all aspects of the irrigation machine including but not limited to: pumps, valves, sprinklers, variable rate irrigation, water pressure, shape of distribution pattern, rate of travel and the like.

[0009] The accompanying drawings illustrate various embodiment and together with the description, serve to explain the principles of the present invention.

Brief Description of the Drawings

[0010]

FIG. 1 shows an exemplary irrigation system for use with the present invention.

FIG. 2 shows a block diagram illustrating the exemplary processing architecture of a control device in according with a first preferred embodiment of the present invention.

FIG. 3 shows a block diagram in accordance with further preferred embodiment of the present invention.

Description of the Preferred Embodiments

[0011] For the purposes of promoting an understanding of the principles of the present invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same.

[0012] The terms "program," "computer program," "software application," "module" and the like as used herein, are defined as a sequence of instructions designed for execution on a computer system. A program, computer program, module or software application may include a subroutine, a function, a procedure, an object implementation, an executable application, an applet, a servlet, a source code, an object code, a shared library, a dynamic load library and/or other sequence of instructions designed for execution on a computer system. A data storage means, as defined herein, includes many different types of computer readable media that allow a computer to read data therefrom and that maintain the data stored for the computer to be able to read the data again. Such data storage means can include, for example, non-volatile memory, such as ROM, Flash memory, battery backed-up RAM, Disk drive memory, CD-ROM, DVD, and other permanent storage media. However, even volatile storage such a RAM, buffers, cache memory, and network circuits are contemplated to serve as such data storage means.

[0013] Aspects of the systems and methods described herein may be implemented as functionality programmed into any of a variety of circuitry, including programmable logic devices (PLDs), such as field programmable gate arrays (FPGAs), programmable array logic (PAL) devices, electrically programmable logic and memory devices and standard cell-based devices, as well as application specific integrated circuits (ASICs). Some other possibilities for implementing aspects of the systems and methods includes: microcontrollers with memory, embedded microprocessors, firmware, software, etc. Furthermore, aspects of the systems and methods may be embodied in microprocessors having software-based circuit emulation, discrete logic (sequential and combinatorial), custom devices, fuzzy (neutral network) logic, quantum devices, and hybrids of any of the above device types. Of course, the underlying device technologies may be provided in a variety of component types, e.g., metal-oxide semiconductor field-effect transistor (MOSFET) technologies like complementary metal-oxide semiconductor (CMOS), bipolar technologies like emitter - coupled logic (ECL), polymer technologies (e.g., silicon-conjugated polymer and metalconjugated polymer-metal structure), mixed analog and digital, and the like.

[0014] FIG. 1 illustrates an exemplary self-propelled irrigation system 100 which may be used with example implementations of the present invention. As should be understood, the irrigation system 100 disclosed in FIG. 1 is an exemplary irrigation system onto which the features of the present invention may be integrated. Accordingly, FIG. 1 is intended to be illustrative and any of a variety of systems (i.e. fixed systems as well as linear and center pivot self-propelled irrigation systems; stationary systems; corner systems) may be used with the present invention without limitation.

[0015] With reference now to FIG. 1, an exemplary self-propelled irrigation system 100 preferably may include spans 102, 104, 106 supporting drive towers 108, 109, 110. Further, each drive tower 108, 109, 110 is shown with respective drive controllers 112, 113, 114. For each drive tower, 108, 109, 110, the respective drive controllers 112, 113, 114 may generally control respective drive motors 117, 119, 120 and drive wheels 115, 116, 118. Further, such irrigation machines 100 may generally include an extension/overhang 121 which may include an end gun (not shown).

[0016] With reference now to FIG. 2, an exemplary control device 138 which represents functionality to control one or more operational aspects of the irrigation system 100 will now be discussed. As shown, an exemplary control device 138 in accordance with the present invention may preferably include a processor 140, a memory 142, one or more modules 141, 143, 145, 147 and a network interface 144 to communicate with one or more networks 146. As further shown, the memory 142 of the exemplary control device 138 may preferably further include a module containing irrigation path data 150 which may further include water application rates, vehicle speed and motor operations data, as well as adjustment data produced, calculated and stored by the various modules of the present invention. For example, such data may include data from the Throw Calculation Module 145, the Waste Calculation Module 141, the Pressure and Angle Adjustment Module 147 and other data sources as discussed in more detail below.

[0017] Preferably, the processor 140 of the present invention provides processing functionality for the control device 138 and may include any number of processors, microcontrollers, or other processing systems. The processor 140 may execute one or more software programs that implement techniques described herein. The memory 142 is preferably an example of tangible computer-readable media that provides storage functionality to store software programs, code segments and various data associated with the operation of the control device 138, the processor 140 and other elements of the disclosed system and to perform the steps described herein. The memory 142 may include, for example, removable and non- removable memory elements such as RAM, ROM, Flash (e.g., SD Card, mini-SD card, micro-SD Card), magnetic, optical, USB memory devices, and so forth. The network interface 144 preferably provides functionality to enable the control device 138 to communicate with one or more networks 146 through a variety of components such as wireless access points, transceivers and so forth, and any associated software employed by these components (e.g., drivers, configuration software, and so on).

[0018] In implementations, the irrigation position-determining module 148 may include a global positioning system (GPS) receiver or the like to calculate a location of the irrigation system 100. Further, the control device 138 may be coupled to a guidance device or similar system 152 of the irrigation system 100 (e.g., steering assembly or steering mechanism) to control movement of the irrigation system 100. As shown, the control device 138 may further include a positional -terrain compensation module 151 to assist in controlling the movement and locational awareness of the system. Further, the control device 138 may preferably further include multiple inputs and outputs to receive data from sensors 154 and monitoring devices as discussed further below.

[0019] As further shown, a preferred embodiment of the present invention may preferably further include: a Wind, Angle and Throw Calculation Module 145 ("Throw Module" 145); a Waste Calculation Module 141 ("Waste Module") and a Pressure and Angle Adjustment Module 147
("Adjustment Module" 147). According to a preferred embodiment of the present invention, the Throw Module 145 preferably receives field mapping data, water pressure and weather data which may preferably include wind speed, wind direction, humidity and barometric pressure from the sensor systems as discussed further below. From these data inputs, the Throw Module 145 preferably calculates the length of the throw (alternatively referred to as the "throw" or "reach") for one or more of the sprinklers of the system (i.e. sprayers, nozzles, end guns and the like) for a range of water pressures and settings/parameters (defined herein to include angles of travel, trajectory, nozzle/sprinkler settings and the like) which each sprinkler may be programmed to execute. Preferably, the Throw Module 145 is programmed to receive continual updates of both weather conditions and water pressure levels so that it may dynamically calculate and update throw calculations in real-time as the irrigation system executes a given watering plan. Further in accordance with aspects of the present invention, the Throw Module 145 may preferably be programmed to receive: irrigation map data (i.e. GPS dimensions of a given field); weather data (including humidity, temperature, wind speed and direction); movement data (including speed and direction of the irrigation machine); and topographical data (including data regarding the slope of the terrain to be irrigated).

[0020] According to a further preferred embodiment, the Throw Module 145 preferably may continually feed the results of its calculations to Adjustment Module 147. Such calculations may further include factors and inputs such as: safety zones, guidance tower speed, max ET ratio, minimum Arc Radius, full or partial circle, max/min trajectories, start/end angles and the like.

[0021] According to a further preferred embodiment, the Adjustment Module 147 may preferably be linked to the control systems (i.e. transducers 326, 328, 329 discussed further below) to control and regulate water pressure including being linked to any pressure boosting systems. Further, the Adjustment Module 147 may preferably be further linked to systems which control and adjust sprinkler settings/parameters. Additionally, the Adjustment Module 147 may preferably be further linked to and receive positioning information from the irrigation positioning module 148 and other mapping systems so that the Adjustment Module 147 may calculate the optimal throw settings desired for each sprinkler. Preferably, based on the dynamically updated throw calculations from the Throw Module 145, the Adjustment Module 147 may preferably independently and dynamically adjust the water pressure and/or sprinkler settings/parameters (including angles of travel, trajectory and nozzle/-sprinkler settings) so that the output from each sprinkler stays within the boundaries of the given area to be irrigated.

[0022] According to further aspects of the present invention, as the irrigation system is executing an irrigation plan to apply water within a given set of boundaries, Adjustment Module 147 may preferably receive instantaneous updates regarding the reach of each sprinkler and make adjustments accordingly. For example, on a windy day Adjustment Module 147 may increase water pressure (and/or change the sprinkler settings/parameters) when a sprinkler is projecting water against the wind direction. Alternatively, the Adjustment Module 147 may operate to decrease water pressure (and/or change the sprinkler settings/parameters) when a sprinkler of the system is projecting water with the direction of the wind. According to a further preferred embodiment, Adjustment Module 147 may preferably likewise take into account changes in the mapped boundaries and location of the irrigation system as it moves to adjust the throw pattern of the sprinkler.

[0023] In operation, the Throw Module 145 preferably receives data regarding irrigation map data (i.e. dimensions of a given field); weather data (including humidity, temperature, wind speed and direction); movement data (including speed and direction of the irrigation machine);

and topographical data (including data regarding the slope of the terrain to be irrigated). Preferably, such data includes the GPS coordinates (or the like) which define the area to be irrigated as well as the irrigation plan for directing water (or other applicant) to the area. Using the irrigation map data, the weather data, the topographic data, and the travel data, the Throw Module 145 preferably may determine a corrected irrigation plan which includes selected system adjustments to target an applicant(s) onto the designated irrigation area. As discussed above, these selected adjustments, may preferably include: increase/decrease of water pressure; changes to sprinkler settings/parameters; adjustments to the changes in the travel speed and direction and the like.

[0024] With further reference to FIG. 2, the system of the present invention may preferably further include a Waste Module 141 which preferably calculates the amount of wasted and/or over-applied applicant expected from both the original irrigation plan and the corrected irrigation plan. Further, the Waste Module 141 preferably is further configured to provide a calculation of the different energy/fuel costs expected in executing the original irrigation plan and the corrected irrigation plan. Preferably, these comparisons may be used by the processor 140 to determine whether to make corrections to the original irrigation plan. Alternatively, the comparisons calculated by the Waste Module 141 may be presented and displayed to the operator to make determinations regarding which irrigation plan to execute. According to a further preferred embodiment, the Waste Module 141 may further provide additional individual calculations of the expected applicant waste and energy/fuel costs for individual adjustments to the original irrigation plan which may preferably be individually selected or declined by the operator.

[0025] With reference now to FIG. 3, an exemplary system incorporating aspects of the present invention shall now be further discussed. As shown, an exemplary irrigation system may include transducers 326, 328, 329 which control and regulate water pressure to sprinklers including the end gun 321 and other sprinkler heads 335. Further the system may preferably include drive units 316, 324 which are preferably programed to monitor and control portions of the irrigation unit drive system. Further, the system of the present invention may preferably further include elements such as a GPS receiver 320 for receiving positional data and a flow meter 332 for monitoring water flow in the system. Still further, a system of the present invention may further include indirect crop sensors 314, 318 which preferably may include moisture sensors to determine the moisture levels in a given area of soil. Additionally, the indirect crop sensors 314, 318 may further include optics to allow for the detection of crop type, stage of grown, health, presence of disease, rate of growth and the like. Still further, the system may include ground sensors 330. Still further, the detection system may further include a weather station 322 or the like which is able to measure weather features such as humidity, wind speed, wind direction, pressure, precipitation, and the like. Still further, the system may preferably further include a wireless transceiver/router 311 for receiving and transmitting signals between system elements.

[0026] In operation, the system of the present invention may also preferably calculate and adjust the movement of the irrigation drive system to compensate for changes in the throw/distribution patterns calculated from the weather data and/or positional information. For example, the irrigation system of the present invention may preferably calculate and execute a first water distribution and/or travel pattern based on a first detected set of weather data and/or field dimensions. Thereafter, based on updated weather data and/or field dimensions, the system may make adjustments to the first water distribution/travel pattern to create a second water distribution and/or travel pattern. Accordingly, the system may determine to travel closer to or further from a first boundary based on detected weather conditions such as a given wind pattern (i.e. speed and/or direction). Further, as discussed further herein, the system of the present invention may change the water distribution pattern by controlling and changing the parameters of individual sprinklers alone or in conjunction with other irrigation system parameters. Still further, the system of the present invention may simultaneously change multiple parameters of the irrigation system including the water pressure, travel speed, travel pattern and/or endgun settings/parameters to create a desired water distribution pattern.

[0027] Preferably, the data collected by the detectors and sensors connected to the span 310 are forwarded to a main control panel 308 which preferably includes: a CPU, memory, and processing software to receive and process collected data (including Throw Module 145 as discussed above with respect to FIG. 2), and one or more elements of control device 138 (including the Adjustment Module 147 as discussed above with respect to FIG. 2).

[0028] According to alternative preferred embodiments, any one of the processes discussed above with respect to the main control panel 308 may alternatively be performed on a remote server 306 with any data and/or control signals transmitted between the main control panel 308 and the remote server 306. Still further, the system may preferably further include a remote sensing element such as a sensor suite located on an unmanned aerial vehicle 302 (UAV), satellite 304 or other high-altitude monitoring system which may preferably provide weather and other data to the remote server 306 and/or to the main control panel 308.

[0029] As discussed above, the control panel 308 of the present invention preferably may monitor the system location in relation to a mapped set of boundaries in coordination with a field specific program. During operation, the control panel 308 may preferably receive data regarding field dimensions, changes in the irrigation plan/pattern, and/or data regarding weather factors (such as wind speed, direction, averages, and gusts) and preferably makes adjustments to the system (i.e. water pressure, sprinkler settings/parameters, system travel speed/direction) to adjust and modify the shape of the desired distribution area. Accordingly, the control panel 308 may preferably monitor the irrigation program and the location of individual sprinklers to adjust system/-sprinkler settings in response to sensor inputs and thereby create a desired distribution pattern/area. According to further preferred embodiment, the system of the present invention may preferably further calculate adjustments to the system based on other factors including: droplet size, applicant type, height of nozzle from the ground, speed of irrigation system travel and the like. Further, the system of the present invention may preferably further adjust a given designed distribution pattern based on additional factors such as: rate of rain fall, pH of rain fall, sunlight levels, rates of temperature change and the like.

[0030] While the above descriptions regarding the present invention contain much specificity, these should not be construed as limitations on the scope, but rather as examples. Many other variations are possible. For example, the processing elements of the present invention by the present invention may operate on a number of frequencies. Further, the communications provided with the present invention may be designed to be duplex or simplex in nature. Further, as needs require, the processes for transmitting data to and from the present invention may be designed to be push or pull in nature. Still, further, each feature of the present invention may be made to be remotely activated and accessed from distant monitoring stations. Accordingly, data may preferably be uploaded to and downloaded from the present invention as needed.

[0031] Accordingly, the scope of the present invention should be determined not by the embodiments illustrated, but by the appended claims.

Claims

1. A system for use with a variable rate irrigation system (100) having at least one irrigation span (102, 104, 106) and a drive system for moving the irrigation span, wherein the drive system comprises drive towers (108, 109, 110) ; wherein the system comprises:

   a plurality of sprinklers wherein the sprinklers receive water under pressure and spray the water onto a field to be irrigated;
   weather sensors (154), wherein at least one weather sensor is configured to detect humidity, pressure, precipitation, wind speed and direction, or temperature;
   a processing system, wherein the processing system is programmed to execute an irrigation plan; further wherein the processing system monitors a mapped set of boundaries and receives weather data from one or more weather sensors; further wherein the processing system estimates the range or throw length of the sprinklers based at least in part on the weather data and on water pressure data;
   and,
   a control system (326, 328, 329), wherein the control system receives instructions from the processing system and adjusts to irrigation system parameters;
   a throw module (145), wherein a throw module (145) calculates a throw length of at least one sprinkler based on inputted data; wherein the throw length is the horizontal distance which the sprinkler is able to project a given applicant;
   wherein the inputted data comprises
   field mapping data, water pressure data and weather data;
   wherein the weather data comprises wind speed, wind direction, humidity and barometric pressure;
   characterised in that the throw module (145) calculates the throw length for a plurality of sprinklers based at least in part on the received water pressure data and the weather data;
   wherein the throw module (145) calculates the throw length for a plurality of water pressures and sprinkler parameters;
   wherein the sprinkler parameters are comprised of two parameters: the angles of travel, and trajectory and/or nozzle settings; wherein the throw module (145) calculates the throw length for the plurality of sprinklers based on movement data of the drive tower (108, 109, 110);
   wherein the movement data comprises a speed and direction of an irrigation system;
   wherein the system comprises a control panel (308) which is configured to change a prescribed route in the irrigation plan based on the detected wind speed and direction;
   wherein the control panel (308) is configured to change a travel speed in the irrigation plan based on the calculated throw length for the plurality of sprinklers, wherein
   the throw module (145) receives continual updates of weather data and water pressure data and dynamically calculates and updates the throw lengths in real-time as the irrigation system executes the irrigation plan, and
   calculates the throw lengths for a plurality of sprinklers based upon the movement data and at least in part on the group of data comprising: irrigation map data; weather data; and
   topographical data;
   wherein the throw lengths are calculated based at least in part on the group of data comprising:

safety zones, guidance tower speed, max ET ratio, minimum Arc Radius, full or partial circle, max/min trajectories, and start/end angles;
wherein the system further comprises an adjustment module (147); wherein the adjustment module (147) is linked to a control system and is configured to control and regulate water pressure and to adjust sprinkler parameters;
wherein the adjustment module (147) receives irrigation plan data and location data; further wherein the adjustment module (147) changes a plurality of the sprinkler parameters based at least in part on throw calculations from the throw module (145);
wherein the parameters are changed to reduce the sprinkler throw distances for a first sprinkler to less than the distance between the first sprinkler and each irrigation boundary during the execution of the irrigation plan;
wherein the sprinkler parameters comprise: angles of travel, trajectory and nozzle/sprinkler settings, and
the system increases water pressure and changes sprinkler parameters when a sprinkler is projecting an applicant against the wind direction.

2. The system of claim 1, wherein the system decreases water pressure and changes sprinkler parameters when a sprinkler of the system is projecting an applicant with the direction of the wind.

3. The system of claim 2, wherein the system changes the route for a given irrigation plan based on the detected wind speed and direction.

4. The system of claim 3, wherein the system comprises a waste module (141), wherein the waste module calculates the amount of over-spray and the amount of over-applied applicant expected from both an original irrigation plan and an adjusted irrigation plan.

5. The system of claim 3, wherein the waste module (141) is configured to provide a calculation of the different energy costs expected in executing the original irrigation plan and the adjusted irrigation plan.

6. The system of claim 5, wherein the calculation of different energy costs is used by the processor to determine whether to make corrections to the original irrigation plan.

7. The system of claim 6, wherein at least one waste module calculation is displayed to an operator to make determinations regarding which irrigation plan to execute.

8. The system of claim 1, wherein the irrigation system receives and executes a first water distribution plan and a first route of travel based on a first detected set of weather data; and creates a second water distribution plan and a second route of travel based on updated weather data.

Patentansprüche

1. System für die Verwendung mit einem Bewässerungssystem (100) mit variabler Rate und mindestens einem Bewässerungsbereich (102, 104, 106) und einem Antriebssystem für das Bewegen des Bewässerungsbereichs, wobei das Antriebssystem Antriebsmasten (108, 109, 110) umfasst; wobei das System Folgendes umfasst:

Eine Vielzahl von Sprinklern, wobei die Sprinkler druckbeaufschlagtes Wasser empfangen und das Wasser auf ein zu bewässerndes Feld sprühen;
Wettersensoren (154), wobei mindestens ein Wettersensor konfiguriert ist, Feuchtigkeit, Druck, Niederschlag, Windgeschwindigkeit und -richtung oder Temperatur zu erfassen;
ein Verarbeitungssystem, wobei das Verarbeitungssystem programmiert ist, einen Bewässerungsplan auszuführen; ferner wobei das Verarbeitungssystem einen kartierten Satz von Grenzen überwacht und Wetterdaten von einem oder mehreren Wettersensoren empfängt; ferner wobei das Verarbeitungssystem den Bereich oder die Sprühweite der Sprinkler mindestens teilweise basierend auf Wetterdaten und Wasserdruckdaten schätzt;
ein Steuerungssystem (326, 328, 329), wobei das Steuerungssystem Anweisungen von dem Verarbeitungssystem empfängt und die Bewässerungssystem-Parameter einstellt;
ein Sprühmodul (145), wobei das Sprühmodul (145) eine Sprühweite von mindestens einem Sprinkler basierend auf Eingabedaten berechnet; wobei die Sprühweite der horizontale Abstand ist, die der Sprinkler in der Lage ist, ein gegebenes Anwendungsmittel auszuwerfen;
wobei die Eingabedaten Feldkartierungsdaten, Wasserdruckdaten und Wetterdaten umfassen;
wobei die Wetterdaten Windgeschwindigkeit, Windrichtung, Feuchtigkeit und Luftdruck umfassen;
dadurch gekennzeichnet, dass das Sprühmodul (145) die Sprühweite für eine Vielzahl von Sprinklern mindestens teilweise basierend auf den empfangenen Wasserdruckdaten und den Wetterdaten berechnet;
wobei das Sprühmodul (145) die Sprühweite für eine Vielzahl von Wasserdrücken und Sprinkler-

Parametern berechnet;
wobei die Sprinkler-Parameter aus zwei Parametern bestehen: Den Verfahrwinkeln, und der Sprühweg- und/oder Düseneinstellung;
wobei das Sprühmodul (145) die Sprühweite für die Vielzahl der Sprinkler basierend auf den Bewegungsdaten des Antriebsmasts (108,109,110) berechnet;
wobei die Bewegungsdaten eine Geschwindigkeit und eine Richtung eines Bewässerungssystems umfassen;
wobei das System eine Steuertafel (308) umfasst, die konfiguriert ist, eine vorgeschriebene Strecke im Bewässerungsplan basierend auf der erfassten Windgeschwindigkeit und -richtung zu ändern;
wobei die Steuertafel (308) konfiguriert ist, eine Fahrgeschwindigkeit in dem Bewässerungsplan, basierend auf der berechneten Sprühweite für die Vielzahl von Sprinklern zu ändern,
wobei das Sprühmodul (145) fortlaufende Aktualisierungen von Wetterdaten und Wasserdruckdaten empfängt und dynamisch die Sprühweite in Echtzeit berechnet und aktualisiert, während das Bewässerungssystem den Bewässerungsplan ausführt, und
die Sprühweiten für eine Vielzahl von Sprinklern basierend auf den Bewegungsdaten und mindestens teilweise auf der Gruppe von Daten umfassend: Bewässerungskartendaten; Wetterdaten und topographische Daten berechnet;
wobei die Sprühweiten mindestens teilweise basierend auf den Gruppen von Daten berechnet werden, umfassend: Sicherheitsbereiche, Führungsmast-Geschwindigkeit, max. ET-Verhältnis, Mindestbogenradius, Vollkreis oder Teilkreis, max./min. Sprühwege und Start-/Endwinkel;
wobei das System ferner ein Einstellmodul (147) umfasst; wobei das Einstellmodul mit einem Steuerungssystem verbunden und konfiguriert ist, einen Wasserdruck zu steuern und zu regeln und Sprinkler-Parameter einzustellen;
wobei das Einstellmodul (147) Bewässerungsplandaten und Standortdaten empfängt; ferner wobei das Einstellmodul (147) eine Vielzahl von Sprinkler-Parametern mindestens teilweise basierend auf Sprühberechnungen aus dem Sprühmodul (145) ändert;
wobei die Parameter geändert werden, um die Sprühweiten des Sprinklers für einen ersten Sprinkler während der Ausführung des Bewässerungsplans auf weniger als die Entfernung zwischen dem ersten Sprinkler und jeder Bewässerungsgrenze zu reduzieren;
wobei die Sprinkler-Parameter umfassen: Verfahrwinkel, Sprühweg und Düsen/Sprinklereinstellung, und
das System erhöht den Wasserdruck und ändert die Sprinkler-Parameter, wenn ein Sprinkler ein Anwendungsmittel gegen die Windrichtung auswirft.

2. System nach Anspruch 1, wobei das System den Wasserdruck absenkt und Sprinkler-Parameter ändert, wenn ein Sprinkler des Systems ein Anwendungsmittel mit der Windrichtung auswirft.

3. System nach Anspruch 2, wobei das System die Strecke für einen gegebenen Bewässerungsplan basierend auf der erfassten Windgeschwindigkeit und -richtung ändert.

4. System nach Anspruch 3, wobei das System ein Verlustmodul (141) umfasst, wobei das Verlustmodul die Menge an zu viel versprühtem Wasser und die Menge an zu viel verwendetem Anwendungsmittel berechnet, die von einem ursprünglichen Bewässerungsplan und einem angepassten Bewässerungsplan erwartet werden.

5. System nach Anspruch 3, wobei das Verlustmodul (141) konfiguriert ist, eine Berechnung der verschiedenen Energiekosten bereitzustellen, die bei der Ausführung des ursprünglichen Bewässerungsplans und des angepassten Bewässerungsplans erwartet werden.

6. System nach Anspruch 5, wobei die Berechnung der verschiedenen Energiekosten von dem Prozessor verwendet wird, um zu bestimmen, ob Korrekturen an dem ursprünglichen Bewässerungsplan vorzunehmen sind.

7. System nach Anspruch 6, wobei einem Bediener mindestens eine Verlustmodul-Berechnung angezeigt wird, um zu bestimmen, welcher Bewässerungsplan ausgeführt werden soll.

8. System nach Anspruch 1, wobei das Bewässerungssystem einen ersten Wasserverteilungsplan und eine erste Verfahrstrecke basierend auf einem ersten erfassten Satz von Wetterdaten empfängt und ausführt; und einen zweiten Wasserverteilungsplan und eine zweite Verfahrstrecke basierend auf aktualisierten Wetterdaten erstellt.

Revendications

1. Système destiné à être utilisé avec un système d'irrigation à débit variable (100) présentant au moins une portée d'irrigation (102, 104, 106) et un système d'entraînement destiné à déplacer la portée d'irrigation, dans lequel le système d'entraînement comprend des tours d'entraînement (108, 109, 110) ;

dans lequel le système comprend : une pluralité d'arroseurs dans lequel les arroseurs reçoivent de l'eau sous pression et pulvérisent l'eau sur un champ à irriguer ;

des capteurs météorologiques (154), dans lequel au moins un capteur météorologique est conçu pour détecter l'humidité, la pression, les précipitations, la vitesse et la direction du vent, ou la température ;

un système de traitement, dans lequel le système de traitement est programmé pour exécuter un plan d'irrigation ; en outre, dans lequel le système de traitement surveille un ensemble cartographié de limites et reçoit des données météorologiques provenant d'un ou plusieurs capteurs météorologiques ; en outre, dans lequel le système de traitement estime la portée ou la longueur de projection des arroseurs en fonction au moins en partie des données météorologiques et des données de pression de l'eau ;

un système de commande (326, 328, 329), dans lequel le système de commande reçoit des instructions provenant du système de traitement et s'ajuste aux paramètres du système d'irrigation ;

un module de projection (145), dans lequel un module de projection (145) calcule une longueur de projection d'au moins un arroseur en fonction des données entrées ; dans lequel la longueur de projection est la distance horizontale sur laquelle l'arroseur est capable de projeter un produit à appliquer donné ;

dans lequel les données entrées comprennent des données cartographiques sur le terrain, des données de pression de l'eau et des données météorologiques ;

dans lequel les données météorologiques comprennent la vitesse du vent, la direction du vent, l'humidité et la pression barométrique ;

caractérisé en ce que le module de projection (145) calcule la longueur de projection destinée à une pluralité d'arroseurs en fonction au moins en partie des données de pression d'eau reçues et des données météorologiques ;

dans lequel le module de projection (145) calcule la longueur de projection destinée à une pluralité de pressions d'eau et de paramètres d'arroseurs ;

dans lequel les paramètres d'arroseur se composent de deux paramètres : les angles de déplacement, et la trajectoire et/ou les réglages de buse ;

dans lequel le module de projection (145) calcule la longueur de projection pour la pluralité d'arroseurs en fonction des données de déplacement de la tour d'entraînement (108, 109, 110) ;

dans lequel les données de déplacement comprennent une vitesse et une direction d'un système d'irrigation ;

dans lequel le système comprend un panneau de commande (308) qui est conçu pour modifier un itinéraire prescrit dans le plan d'irrigation en fonction de la vitesse et de la direction du vent détectées ;

dans lequel le panneau de commande (308) est conçu pour modifier une vitesse de déplacement dans le plan d'irrigation en fonction de la longueur de jet calculée pour la pluralité d'arroseurs,

dans lequel le module de projection (145) reçoit des mises à jour continues de données météorologiques et de données de pression de l'eau et calcule et met à jour de manière dynamique les longueurs de projection en temps réel lorsque le système d'irrigation exécute le plan d'irrigation, et

calcule les longueurs de projection destinées à une pluralité d'arroseurs en fonction des données de déplacement et, au moins en partie, du groupe de données comprenant : les données cartographiques d'irrigation ; les données météorologiques ; et les données topographiques ;

dans lequel les longueurs de projection sont calculées au moins en partie en fonction du groupe de données comprenant : les zones de sécurité, la vitesse de la tour de guidage, le rapport ET max, le rayon d'arc minimal, le cercle complet ou partiel, les trajectoires max/-min et les angles de début/fin ;

dans lequel le système comprend en outre un module d'ajustement (147), dans lequel le module d'ajustement est relié à un système de commande et est conçu pour commander et réguler la pression de l'eau et ajuster les paramètres d'arroseur ;

dans lequel le module d'ajustement (147) reçoit des données de plan d'irrigation et des données de localisation ; en outre, dans lequel le module d'ajustement (147) modifie une pluralité de paramètres d'arroseur en fonction au moins en partie des calculs de projection provenant du module de projection (145) ;

dans lequel les paramètres sont modifiés pour réduire les distances de projection de l'arroseur pour un premier arroseur à moins de la distance entre le premier arroseur et chaque limite d'irrigation pendant l'exécution du plan d'irrigation ;

dans lequel les paramètres d'arroseur comprennent : les angles de déplacement, la trajectoire et les réglages de buse/arroseur, et

le système augmente la pression de l'eau et modifie les paramètres d'un arroseur lorsqu'un arroseur projette un produit à appliquer contre la direction du vent.

2. Système selon la revendication 1, dans lequel le système diminue la pression d'eau et modifie les paramètres d'arroseur lorsqu'un arroseur du système projette un produit à appliquer avec la direction du vent.

3. Système selon la revendication 2, dans lequel le système modifie l'itinéraire pour un plan d'irrigation donné en fonction de la vitesse et de la direction du vent détectées.

4. Système selon la revendication 3, dans lequel le système comprend un module de déchet (141), dans lequel le module de déchet calcule la quantité de surpulvérisation et la quantité de produits à appliquer sur appliqués attendues à la fois d'un plan d'irrigation original et d'un plan d'irrigation ajusté.

5. Système selon la revendication 3, dans lequel le module de déchet (141) est conçu pour fournir un calcul des différents coûts énergétiques attendus lors de l'exécution du plan d'irrigation original et du plan d'irrigation ajusté.

6. Système selon la revendication 5, dans lequel le calcul de différents coûts énergétiques est utilisé par le processeur pour déterminer s'il faut apporter des corrections au plan d'irrigation original.

7. Système selon la revendication 6, dans lequel au moins un calcul de module de déchet est affiché à un opérateur pour effectuer des déterminations concernant le plan d'irrigation à exécuter.

8. Système selon la revendication 1, dans lequel le système d'irrigation reçoit et exécute un premier plan de distribution d'eau et un premier itinéraire de déplacement en fonction d'un premier ensemble détecté de données météorologiques ; et crée un second plan de distribution d'eau et un second itinéraire de déplacement sur la base de données météorologiques mises à jour.

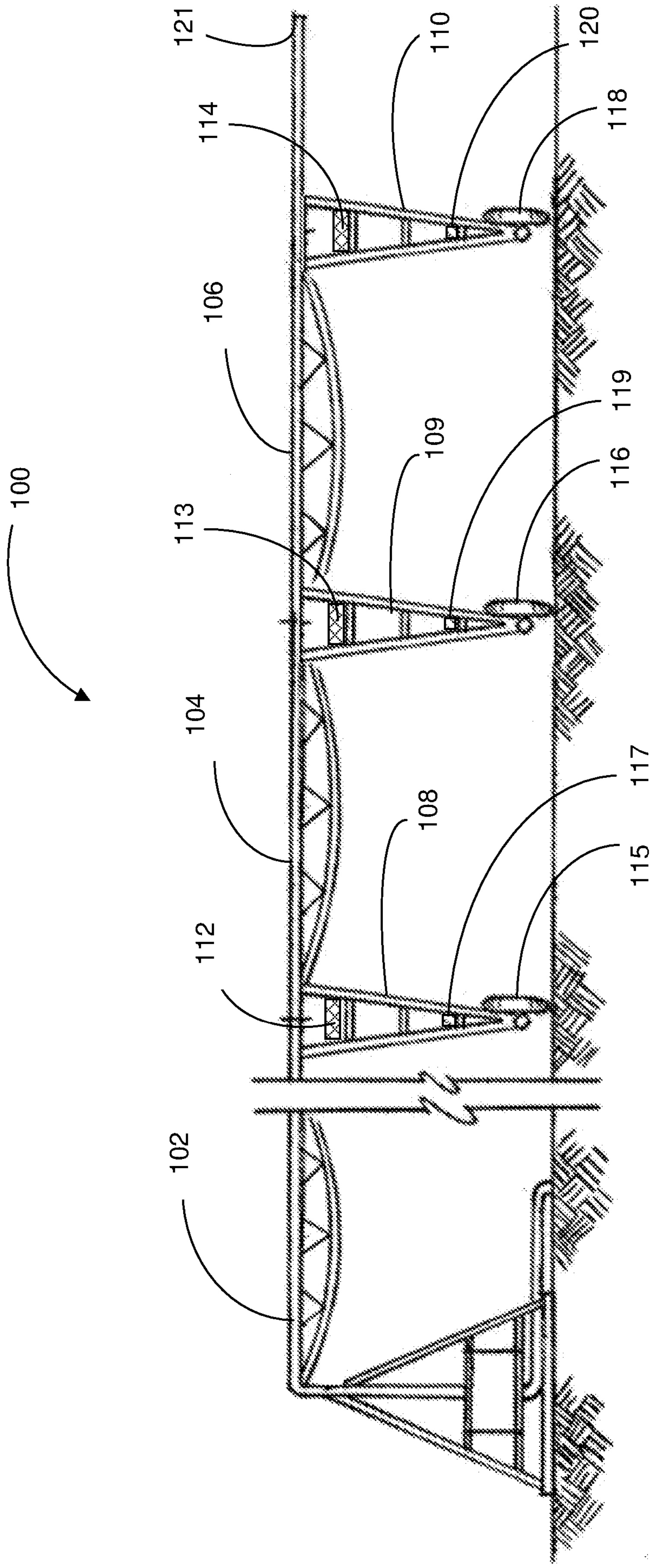
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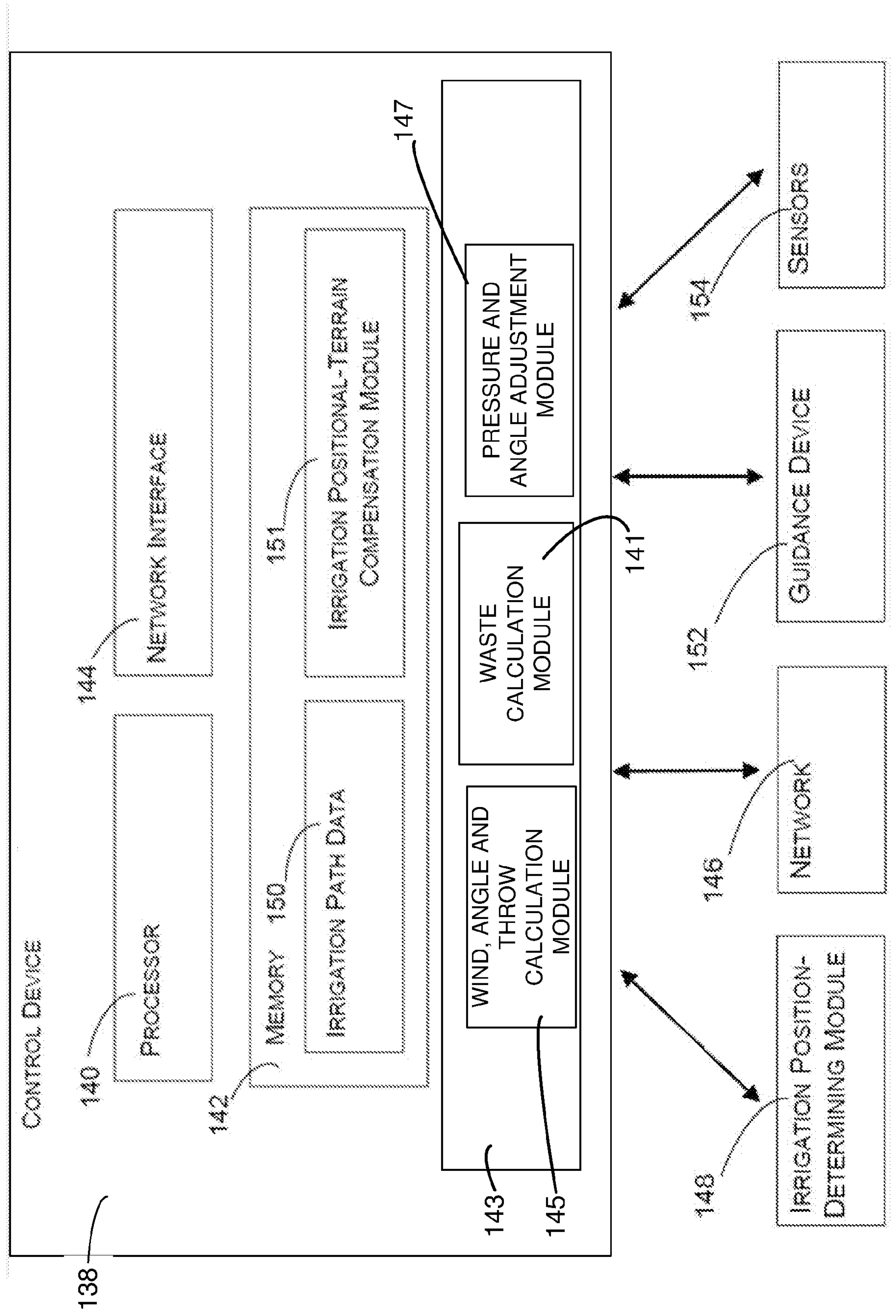
FIG. 1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PROCESSOR
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NETWORK INTERFACE
142
MEMORY
150
IRRIGATION PATH DATA
151
IRRIGATION POSITIONAL-TERRAIN COMPENSATION MODULE
143
145
WIND, ANGLE AND THROW CALCULATION MODULE
WASTE CALCULATION MODULE
141
PRESSURE AND ANGLE ADJUSTMENT MODULE
147
148
IRRIGATION POSITION-DETERMINING MODULE
146
NETWORK
152
GUIDANCE DEVICE
154
SENSORS

FIG. 2

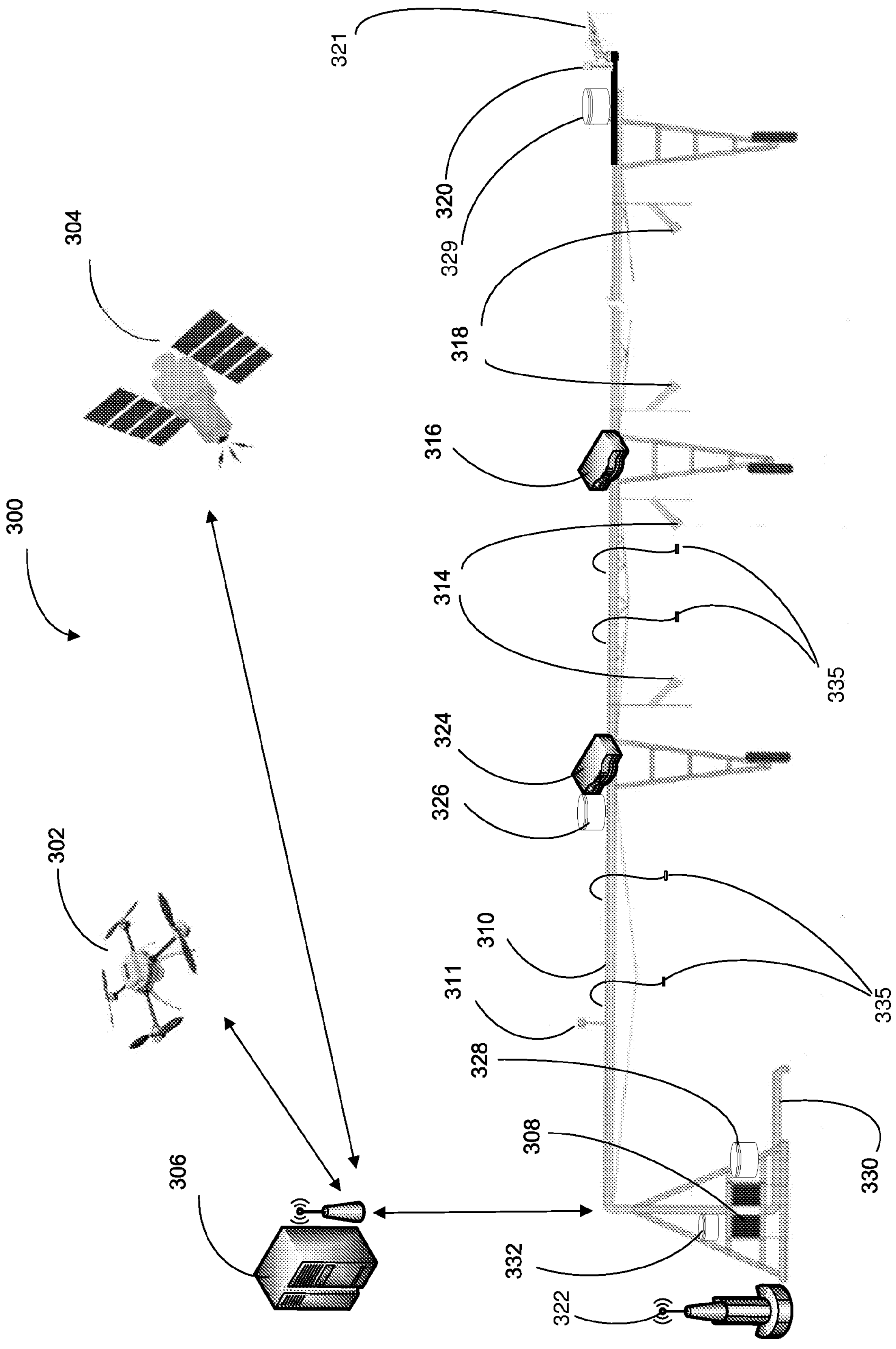
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FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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